United States Naval Observatory

DRAFT

Science Operations Center System

Concept of Operations

DRAFT

28 August 2001

USNO-FAME-SOC-CONOPS
Version 0.2

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1. Scope

1.1. Identification

This concept of operations describes the United States Naval Observatory's (USNO) Science Operations Center's (SOC) support for the Full-sky Astrometric Mapping Explorer (FAME) operations and data analysis.

1.2. System Overview

FAME is an astrometric satellite designed to determine with unprecedented accuracy the positions, distances, and motions of 40 million stars within our galactic neighborhood. It is a collaborative effort between the USNO and several other institutions.

FAME Mission and Science requirement documents levy specific requirements on the SOC system. The SOC is responsible for receiving, archiving and reducing all science and engineering data from the FAME spacecraft along with tracking information from the FAME ground tracking system. The SOC Concept of Operations document describes the conceptual design for a system that meets these requirements. The Concept of Operations document, in turn, is the basis for deriving the requirements contained in this document.

The SOC system is divided into four major subsystems: Data Ingestion (DI), Data Archiving (AR), Quicklook (QL), Data Analysis Trending (TR), and Data Analysis (DA). DI receives all data products from the Mission Operations Center (MOC) and makes them available to the other subsystems. AR copies all received data products to off-line storage media and records location and other relevant metadata in an accessible database. QL processes various data products in order to monitor instrument and spacecraft performance. TR analyzes instrument and spacecraft trending and calculates characterization results for use in data analysis. DA performs the data reduction that takes observations and converts these into astrometric and photometric results.

1.3. Document Overview

This document generally follows the MIL-STD-498 Data Item Description (DID) for an Operation Concept Description (OCD), modified so as to be consistent with the software development methodology specified in the SOC Software Development Plan. The concept of operations do not typically include design or implementation details, but rather describe, at a conceptual level, how information flows through the system and how the component processes act on the data and interact with each other. The primary purpose of this document is to provide a conceptual baseline for requirements analysis and design. Section one gives an overview of the system and this document. Section two is a listing of referenced documents. Section three describes the concept of operations for the SOC system. It is broken down into subsections for DI, AR, QL, TR, and DA subsystems.

The current version of the document addresses only the data analysis system. Draft version 0.3 (and subsequent) will include descriptions of the concept of operations for SOC operations functions.

2. Referenced Documents

This specification references the following documents:

2.1. FAME Mission Documents

Table 1. FAME Mission Documents

Document Number	Description
NCST-D-FM001	FAME Science Requirements Document
NCST-D-FM002	FAME Mission Requirements Document
TBD	FAME Calibration Plan
USNO-FAME-SOC-REQ	SOC System Concept of Operations
USNO-FAME-SOC-MOCICD	MOC-SOC Interface Control Document (ICD)
USNO-FAME-SOC-SDP	SOC Software Development Plan

2.2. Military and Industrial Standards

Table 2. Military and Industrial Standards Documents

Document Number	Description
MIL-STD-498	Software Development and Documentation
DI-IPSC-81431	System/Subsystem Specification
DI-IPSC-81434	Interface Requirements Specification
DI-IPSC-81430	Operational Concept Description

3. SOC Operations Concept

The purpose of the data analysis component of the SOC system is to support ingestion, archiving and processing of the science and auxiliary data for the FAME mission. All of the data are received from the Mission Operations Center (MOC). Once received, they are allocated to the subsystems that compose the overall SOC system for processing. Figure 1 shows the current "Conceptual Design" for the system. The diagram shows the subsystems and component processes that have been identified as being necessary for the SOC to meet science and mission requirements. In the current system, the Data Ingest, Archive and Quicklook subsystems are launch critical, indicating that these systems must be in place and operational prior to launch. The Data Analysis and Trending subsystems are non-launch critical.

This conceptual analysis is not intended to impose a particular design on the system. It is used primarily to derive system, subsystem requirements and interface specifications. In the following sections we describe the purpose and function of each of the subsystems and processes.

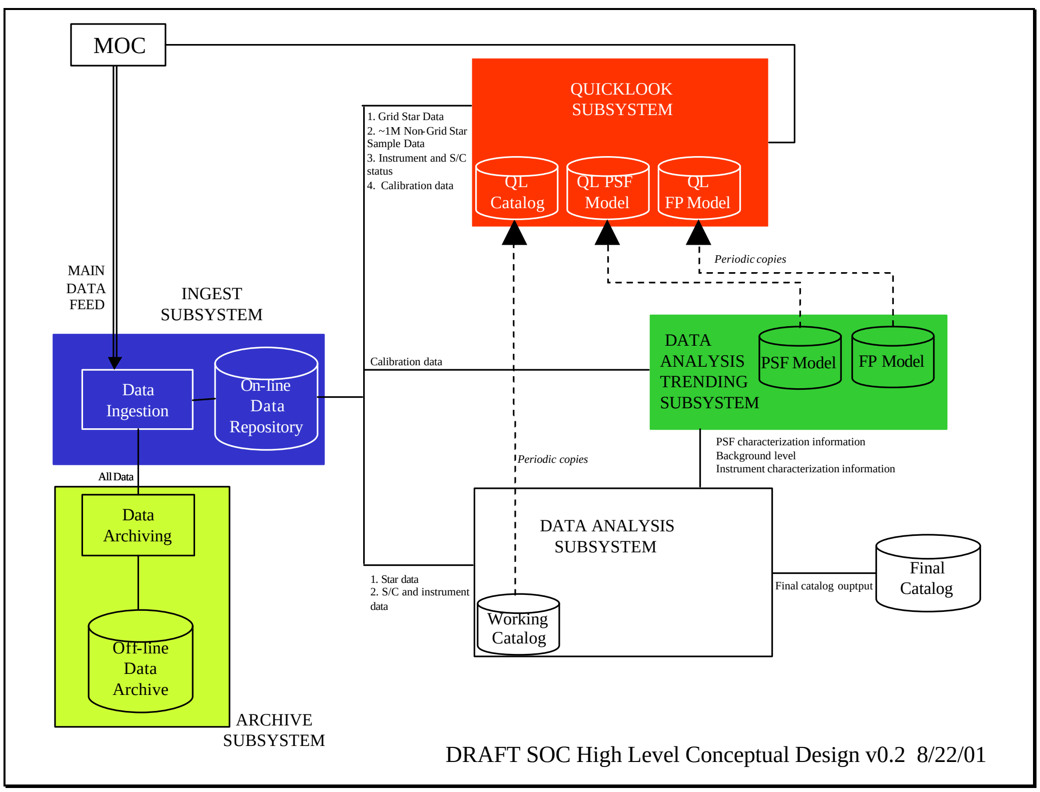

Fig. 1. SOC Conceptual Design

3.1. Data Ingest (DI)—LAUNCH CRITICAL

The DI is responsible for receiving all files from the MOC. The DI will provide a staging area for the MOC to push files to and will check this area at regular (< 1 minute intervals) and attempt to classify any file it detects in the staging area. It will classify and parse these files, and the information and data within the files will be written to the On-Line Repository (OLR). The OLR is the primary means of access for the other subsystems to the raw data and instrument and spacecraft information.

3.1.1 File recognition

All files in the staging area will be classified as one of the following types:

- Science Data file
- Full Frame CCD Readout file
- Acquisition Window file
- Charge Injection test file
- Catalog Dump file
- Focus Test file
- Instrument Attitude file
- SOH file
- Ground Station Tracking file
- Time Conversion file

Any file not recognized as one of these file types will be copied to an "unknown file type" storage area, an operator message will be generated indicating receipt of an unknown file, and the original file will be removed from the staging area.

3.1.2 Ingestion of recognized file types

Each of the recognized file types will be removed from the staging area. A copy of each file "as is" will be made available to the Data Archive subsystem (see next section).

Each recognized file will be parsed and the information and data extracted will be written to the On-Line Repository (OLR). Files received from the MOC will have the following information in them:

File Type	***Information/Data***
Science Data	2-D Grid Star, 2-D Science Star, 1-D Program Star, background, overscan data, time stamp, star ID, gain setting, aperture number, CCD number
Full Frame CCD Readout	Data, time stamp, gain setting, CCD number
Acquisition Window	Data, time stamp, star ID, gain setting, aperture number, CCD number
Charge Injection test	Test data, time stamp, gain setting, CCD number, input waveform number
Catalog Dump	Time stamp, catalog data
Focus Test	Test data, time stamp, gain setting, CCD number, input waveform number
Instrument Attitude	Instrument generated quaternion, time stamp
SOH	Power levels, temperature readings, time stamp
Ground Station Tracking	Position, velocity vectors, time stamp
Time Conversion	Conversion coefficients, time validity range

DI will extract the information from the files and write them to the OLR. DI will distinguish between different types of science data in order to ensure that processes receive the appropriate information. For example, DI must ensure that both the Quicklook and the Trending subsystem access to overscan data windows.

The OLR will make this information available to the other subsystems as discussed below. In general, the information in the OLR is never reprocessed. New information will always be appended. Once the file has been copied to Data Archive and the information within written to the OLR, the original file will be removed from the staging area. The entire process must run at real time speed or better. It must take less than or equal to one second of DI processing time to process one second of actual data.

3.2. Data Archive (AR) Subsystem—LAUNCH CRITICAL

The AR system is a "dumb" archive, which is to say that all data files received from the MOC are archived without any further reprocessing. The purpose of the AR system is to provide backup storage for all received data. Much like standard backups, it is intended to allow for recovery of data files due to some unforeseen problem. The system is not intended to permit regular access to the archived data for standard reprocessing, such as the iterative reprocessing anticipated as part of the Data Analysis system.

The DI will make copies available of each file received from the MOC to AR. Each file will be written to off-line media (such as Digital Versatile Disk (DVD)) for long term storage. In order to keep track of the archived data files, the AR will maintain a database that lists each file received, the data and time of receipt, file type, file size, and where (i.e., on which DVD) the data are located in the AR system.

3.3. Quicklook (QL) pipeline—LAUNCH CRITICAL

The purpose of the QL system is to detect when either the spacecraft or instrument leave nominal operating conditions during the science operations phase of the mission and to initiate appropriate recovery actions. The QL system is primarily concerned with monitoring operations while the instrument is in science mode. Responsibility for the health of the instrument resides at USNO. While primary responsibility for the spacecraft health resides with the Naval Research Lab (NRL), USNO will also monitor spacecraft health status in order to detect anomalous conditions that could affect data collection or reduction. QL will analyze the data from approximately one million (TBR) QL stars and spacecraft and instrument status in order to detect problems with attitude, TDI rate, and other instrument and spacecraft health parameters. Any anomalous condition detections will result in anomaly recovery actions initiated at the SOC and generation of recovery scripts to be sent to the Mission Operations Center (MOC), spacecraft and/or instrument.

The QL process is initiated when the DI receives science profile data for any of the QL stars or calibration test data (i.e., focus test, flatfield observation, charge injection test, overscan data, sky data). QL will also check attitude status of health information regularly. The QL stars consist of approximately one million stars including all grid stars plus one million selected stars that span color, magnitude and spatial parameter space. These sample stars are chosen to span ten color bins and ten magnitude bins and number approximately one hundred stars per spiral scan per color per magnitude bin, or approximately 10^4 stars per spiral. When a data profile is received by DI from any one of these stars, the data is made available to QL and QL processing is initiated.

The 10^6 QL number of stars is the minimum requirement. More stars will produce more accurate results with higher temporal resolution and decrease the average anomaly detection time for any problems that are detected by observing stars. It is therefore desirable that more stars (up to 40 x 10^6) be processed through QL if system performance allows.

When a QL star profile is received, the QL processing begins. The process is shown in fig. 2. QL accesses the data profile and attitude from the OLR. It obtains the corresponding in-band magnitude and color (TBD) metrics from the QL Catalog. Point spread function (PSF) and focal plane characterization information is accessed from QL versions of the PSF and focal plane models. Using this information, QL calculates pixel-coordinate centroids and photometry. This information is written to the QL centroid database.

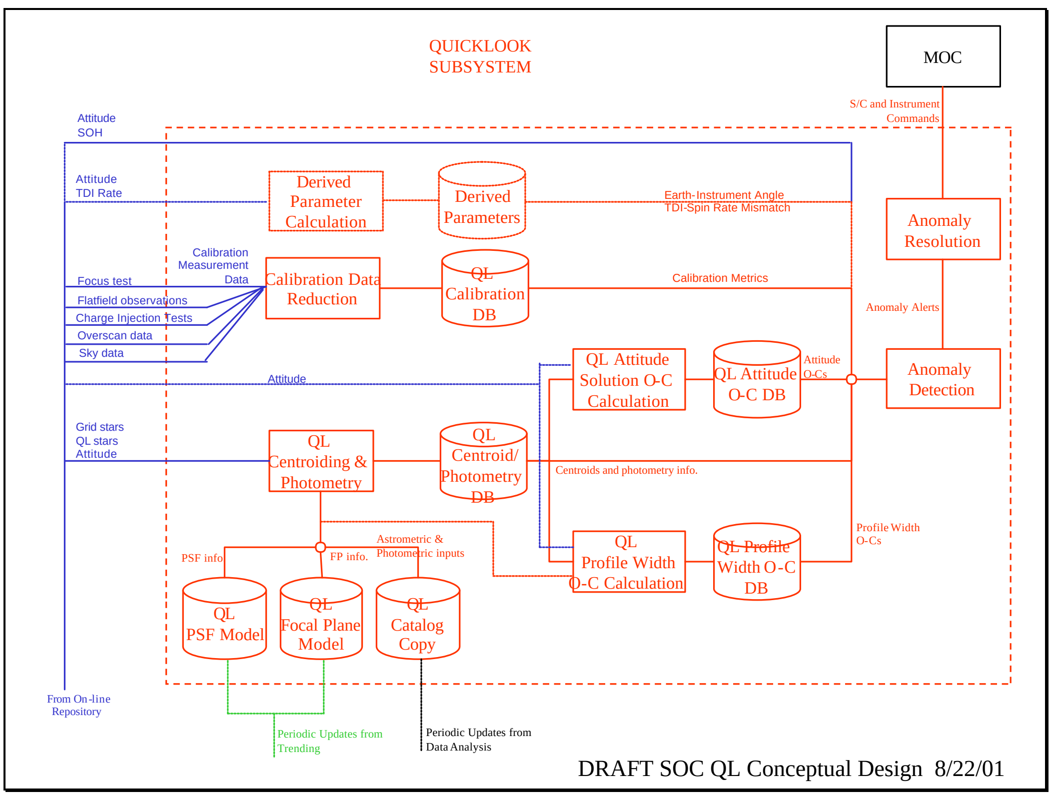

Fig. 2. QL Concept

QL analyzes the calibration data that DI receives using the Calibration Data reduction process. Calibration data is accessed from DI and reduced to TBD calibration metrics in the QL calibration database.

QL models the spacecraft attitude and expected profile widths for stars. These model results are compared to measurement data and the results are written to O-C databases.

The anomaly detection process regularly checks all of these results along with spacecraft attitude and TBD SOH parameters. It typically considers the last ten minutes (TBR) of operation and detects when any of the monitored parameters leaves the specified normal operating condition bounds. When such a condition arises, an anomaly alert is generated and sent to the Anomaly Resolution process.

When an anomalous condition has been identified, the Anomaly Resolution process is initiated. Based on the type of anomaly, a resolution procedure begins which typically results in the generation spacecraft commands being issued to the MOC. Anomaly reports and displays are generated as part of this process.

The entire process must run at real time speed or better. It must take less than or equal to one second of QL processing time to process one second of actual data. (How much data should be retained? Should data be overwritten after a certain time period? TBD)

The component QL processes are described below in more detail:

3.3.1. Rough Centroiding and Photometry

When a science data file is received, the individual profiles are made accessible to the QL Rough Centroiding and Photometry by DI. The star ID is extracted from each profile header, appropriate PSF information is extracted from the QL PSF model and focal plane information is extracted from the QL focal plane model. This information is used along with instrument attitude to calculate the following astrometric and photometric values:

- Centroid in local pixel coordinates, accurate to $1/20^{th}$ pixels (TBR)
- Standard deviation in local pixel coordinates
- Skewness in local pixel coordinates
- Total source brightness in instrumental magnitude (TBR), accurate to $1/10^{th}$ mag. (TBR)
- Uncertainty in source brightness in magnitude.

The process writes this information to the QL Centroiding and Photometry database along with the star ID and time tag information.

3.3.2. Calibration Data Reduction

The calibration data reduction process is initiated when DI receives any of the following calibration data:

1. Focus test
2. Flatfield observation
3. Charge Injection test
4. Overscan data
5. Sky background data

The calibration data reduction process will take this input information and reduce it to TBD calibration metrics. This information includes:

1. Pixel responsivity
2. Column responsivity
3. Column charge transfer efficiency (CTE)
4. CCD bias level
5. CCD electronics and readout noise
6. Dark current
7. Focus metric(s)

This information will be written to the QL calibration database.

3.3.3. Attitude Solution O-C Calculation Process

QL accesses the grid star centroids and the instrument attitude and derives a short time span (~minutes (TBR)) attitude solution for the spacecraft. The difference between this solution and the reported instrument attitude is calculated, and this O-C value is recorded in the QL Attitude O-C database.

3.3.4. Profile Width O-C Calculation Process

For TBD selected stars, QL accesses information from the QL PSF and Focal Plane models, the QL catalog copy and the instrument attitude and generates profile width predictions in both in-scan and cross-scan directions. The process takes the difference between these modeled widths and the measured widths extracted from the QL Centroid/Photometry database. This O-C difference is written to the QL Profile Width O-C database.

3.3.5. Anomaly Detection

The Anomaly Detection process continuously analyzes the data in the OLR and the QL trend databases in order to detect anomalous (out-of-bounds or discontinuities) conditions in specific mission parameters. These specific parameters analyzed for anomalies are described below.

1. Presence of star in window
    a. The presence of a star in the data is verified (from QL Centroiding/Photometry (C/P) DB)
2. Centroid/window center offset
    a. Image centroids for both 1-D and 2-D images are compared with the nominal window centers. (from QL C/P DB)
3. PSF shape
    a. Standard deviation, skewness (i.e., asymmetry) and bimodality are compared with reference bounds. (from QL C/P DB)
    b. O-C profile widths are compared with reference bounds. (from QL Prof. Width O-C DB)
4. Single channel counts
    a. Total counts integrated over TBD time intervals are compared for different CCD channels. (information extracted from QL C/P DB)
5. Selected star counts

   a. Total counts for TBD selected stars are compared for single CCD channels over time (information extracted from QL C/P DB)
   b. Total counts for selected stars are compared for different CCD channels (information extracted from QL C/P DB)
6. Focus and alignment stability
   a. TBD Focus metric(s) are compared to reference bounds (from QL Calibration DB)
7. SOH
   a. Instrument and spacecraft power are compared to reference bounds (from OLR)
   b. Instrument temperature are compared to reference bounds (from OLR)
8. Attitude
   a. Spin rate and spin axis are compared to reference bounds (from OLR)
   b. Precession rate and precession axis are compared to reference bounds (from OLR)
   c. Nutation rate and nutation axis are compared to reference bounds (from OLR)
   d. QL 1 minute attitude solution are compared to instrument reported attitude (from QL Attitude O-C DB)
9. TDI Rate
   a. TDI rate is compared to reference bounds (from OLR)
   b. TDI-spin rate mismatch is compared to reference bounds (from Derived Parameters DB)
10. CCD Sensitivity
    a. Pixel/Column sensitivity is compared to reference bounds (from QL Calibration DB)
11. CCD Bias level
    a. CCD Bias level is compared to reference bounds (from QL Calibration DB)
12. Electronics and readout noise levels
    a. CCD electronics and readout noise levels are compared to reference bounds (from QL Calibration DB)
13. Dark Current
    a. CCD dark current derived from noise-limited sky background observations are compared to reference bounds (from QL Calibration DB)
14. CCD CTE
    a. CCD CTE results from the CTI tests are compared to reference bounds (from QL Calibration DB)

Each of these analyses produces output reports and displays, anomaly condition flags in the trend database and/or alerts as appropriate. Reports will be subject to sorting by CCD channel, column, pixel, star magnitude and star color (at a minimum) as appropriate.

3.3.6. Anomaly Resolution

When an anomalous parameter condition has been detected, the Anomaly Resolution process will attempt to determine the underlying cause. The anomaly type is the cause of the anomalous parameter.

Anomaly types:

1. On board catalog error
2. Attitude problem
    a. Spin rate or spin axis
    b. Precession rate of precession axis
    c. Nutation rate or nutation axis
3. On-board attitude calculation error
4. Spin rate-TDI rate mismatch
5. Out of focus/out of alignment
6. Optics transmission degradation
7. Filter transmission degradation
8. CCD response degradation
    a. Channel
    b. Column
    c. Pixel
9. Dark current variation
10. CCD FPA position variation
11. Bias level variation
12. Electronics noise variation
13. Readout noise variation
14. CTE variation
15. Temperature fluctuation
16. Power fluctuation

Once the anomaly type has been identified by the Anomaly Resolution process, the appropriate anomaly resolution procedure will be initiated. These resolution procedures are currently TBD. It is expected that they will result in SOC and MOC operator actions and instrument and spacecraft command script generation.

3.4. Trending (TR) —NON-LAUNCH CRITICAL

The purpose of the TR system is to calculate all the instrument and background characterization data needed by the QL and DA pipelines to process science data. TR considers both the direct measurements that are produced as part of the instrument calibration activities as well as the iterative results from the data analysis pipeline. The conceptual design for TR is shown in fig. 3. Unlike QL, the TR subsystem is concerned with developing a detailed history of this information over the entire life of the mission.

In order to process this trending information, the DI will make the following information accessible to the TR subsystem:

- TBD PSF reference star profiles
- Sky background profiles
- Flat field outputs
- Charge Injection data
- Blank (dark) field profiles
- Overscan frames
- TBD Transmission Reference Star profiles
- Spacecraft and instrument data
- Instrument attitude
- Focus test
- Data Analysis feedback

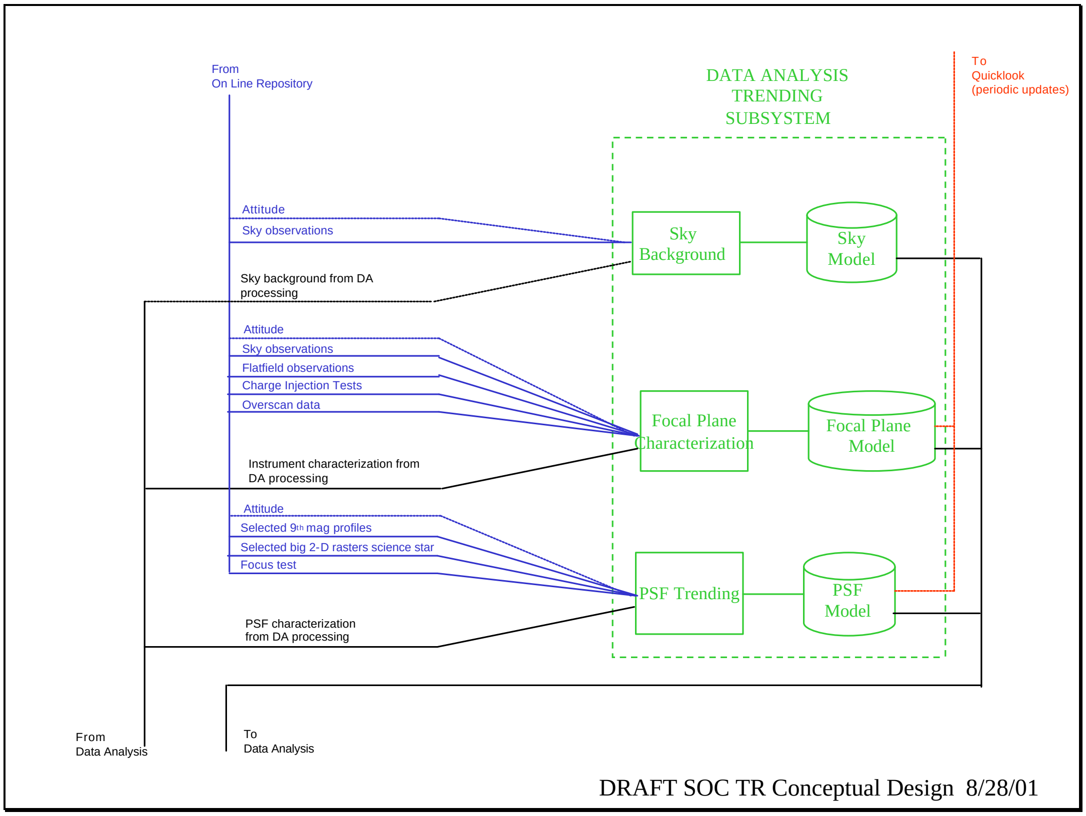

Fig. 3. TR Concept

3.4.1. PSF Trending

The PSF trending process will maintain the model for the PSF for the data analysis pipeline. There are two primary sources of input: direct calibration measurement data and feedback from the data analysis pipeline. Direct calibration inputs such as selected star profiles from 9th mag. stars and large 2-D rasters from science stars, focus test results, and attitude files are accessed from DI and used to update the PSF.

It is also anticipated that the DA system will eventually produce high precision, high accuracy PSF parameter solutions. These will be used by the trending process to modify the PSF model. This modified model may then be used to run the DA process again. Assuming this iterative scheme is stable, the PSF and astrometric and photometric solutions should converge to highly accurate values.

The PSF model will provide information to the DA Centroiding process that will allow the PSF as a function of color, FP position and mission time to be modeled to the required level of accuracy. At TBD intervals, snapshots of this model (or a lower precision representation of the model) will be used to upgrade the PSF model in QL.

3.4.2. Sky Background

As with the PSF Trending process, the Sky Background Characterization will use two basic types of inputs to maintain a model of the focal plane. First, direct measurement in the form of sky background observations will be accessed from DI. This information will be combined with feedback information from DA to produce a model of the background levels as a function of RA, DEC, earth-instrument angle, and time (TBR). The background level information will be used by the DA Centroiding/Photometry process.

3.4.3. Focal Plan (FP) Characterization

As above, the Focal Plane Characterization will use two basic types of inputs to maintain a model of the focal plane. First, calibration data including sky background observations (simulating "darks"), overscans, flatfields, and charge injection tests will all be accessed from DI. Second, as with PSFs, it is anticipated that DA will provide solutions to FP parameters with greater precision and accuracy than possible from use of the calibration data alone. Assuming the method is stable and convergent, the focal plane process will use a combination of the direct measurement data and the DA feedback to develop the FP model.

The FP model will provide focal plane information to the DA Centroiding and Photometry, Global Solution, Astrometric Parameter Calculation, Photometric Calibration and Photometric Parameter Calculation processes as required. At TBD intervals, snapshots of this model (or a lower precision representation of the model) will be used to upgrade the FP model in QL.

3.5. Data Analysis (DA) Pipeline—NON-LAUNCH CRITICAL

The DA pipeline system is the primary mechanism for reducing the FAME observation data. Figure 4 displays the component processes. The DA calculates astrometric and photometric parameters for stars based on input observational data and supporting information. Part of the required set of information used to support the DA processes comes from calculating instrument and background characteristics. These calculations are accessed from TR Subsystem discussed above.

DA data reduction proceeds as follows. Star profiles are made accessible to DA by DI. Initial processing is initiated automatically upon ingest of new star profiles by DI. Alternatively, reprocessing of specified star profiles is initiated upon a receipt of a manual command. The first step in the process is centroiding and photometric analysis. These processes are performed on all star profiles and the results are stored in a database. Next, the global solution process is initiated upon manual command. It solves for the instrument pointing function using grid star centroids, instrument attitude and tracking data. This global solution is then combined with the previously obtained centroiding information to produce astrometric solutions for all non-grid stars. This information is then updated in the catalog.

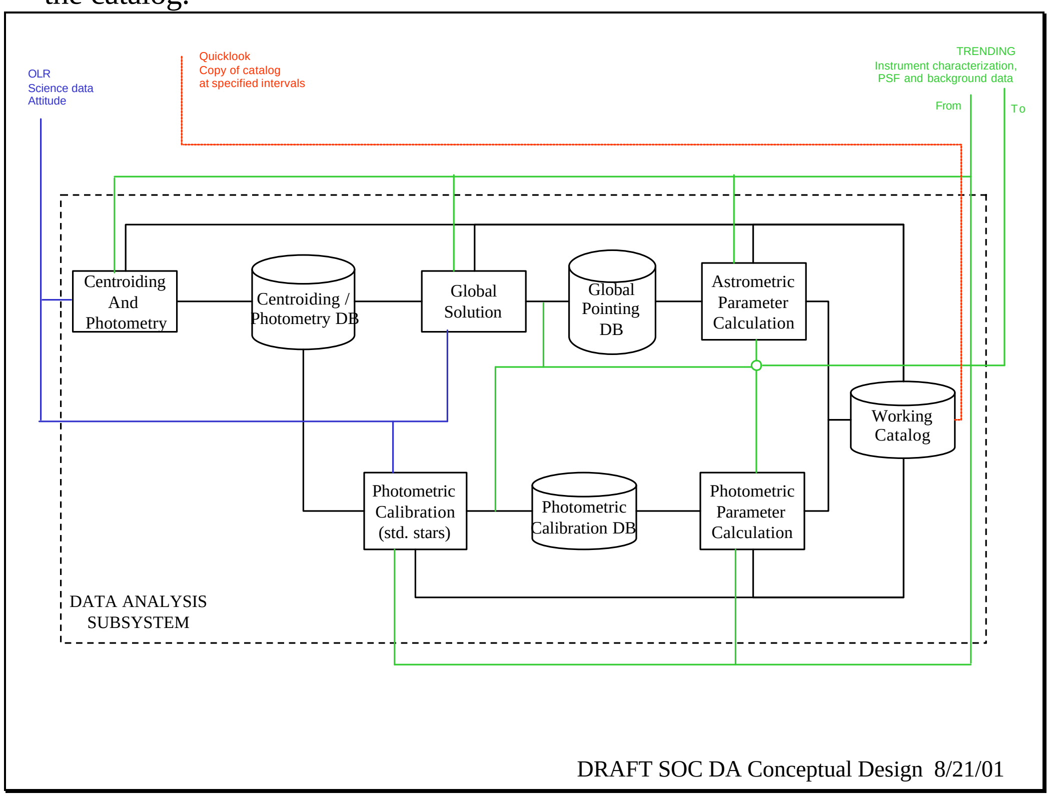

Fig. 4. DA Concept

A concurrent photometric process is also running in DA. Photometric flux values are calculated as part of the centroiding calculation and stored in the centroiding database. Some of these targets are photometric reference stars. The reference stars are combined with the observed flux values to produce calibration coefficients. These coefficients are then used to calculate the photometric parameters for all non-reference stars. This information is updated in the catalog.

The DA system receives inputs from two sources: first, science data and attitude is accessed from the DI subsystem. Second, sky background, instrument and PSF characterization is accessed from the TR subsystem. Output from the DA process is used to populate the working version of the catalog and to produce the final version of the catalog. Instrumental and PSF results that are part of the global solution are used as input to the instrument and PSF trending processes in the TR subsystem.

The system is designed to be run iteratively, i.e., each run through the astrometric or photometric calculations produces more accurate results than the inputs to the system contained in the catalog. This increase in accuracy is obtained because it is anticipated that each run produces instrument characteristics and astrometric and photometric results of increased accuracy. This presumes that these iterations will be stable and will result in a convergence of astrometric, photometric and instrumental values.

While it may be argued that the DA is the single most important part of the FAME data analysis system, it is not needed at launch. The system is therefore classified as non-launch critical for purposes of prioritization.

The component DA processes are described below in more detail:

3.5.1. Centroiding and Astrometric Processing

The centroiding and photometric analysis process (hence: centroiding) begins one of two ways. First, it begins autonomously upon receipt of an unprocessed star data profile. Second, it can begin by manual command when centroids and photometry are recalculated based on updated catalog, instrument or sky background information.

As described above, when centroiding begins, the following information is accessed:

- Star ID (from OLR)
- 1-D or 2-D profile (from OLR)
- Time tag (from OLR)
- CCD gain setting (from OLR)
- CCD ID (from OLR)
- Field Of View (FOV) ID (1 or 2) (from OLR)
- In-band magnitude (preferable) or visible magnitude (from working catalog)
- Photometric in-band band magnitudes (preferable) or color index (from working catalog)
- Known pathology flags (confusion, double star) (from working catalog)
- PSF input information (from TR/PSF model)
- Sky background level (from TR/Sky model)
- Focal plane characterization information (from TR/FP model)

The appropriate PSF information is extracted from the PSF Model and a PSF is produced. The background is subtracted from the profile and the PSF is fit to it. The following information is produced as a result of this fitting process:

- Centroid in local pixel coordinates, accurate to 1/350 (=0.00285714) pixels (TBR)
- Standard deviation in local pixel coordinates
- Skewness in local pixel coordinates

- Kurtosis in local pixel coordinates
- TBD goodness-of-fit metric
- TBD bimodality metric

As part of the fitting process, photometric results are produced. These raw results are deconvolved from the instrumental effects using gain information, sensitivity, PSF, etc., in order to calculate total source brightness and uncertainty in instrumental magnitude.

The process writes these results to the Centroiding/Photometry database along with the star ID and time tag information. If the astrometric statistical moments are outside TBD bounds (for example, if the profile appears to be bi-modal rather than Gaussian) or if the photometric results are sufficiently different from the catalog values, the process flags this as a potentially anomalous observation in the database.

3.5.2. Global Solution

[THIS SECTION WILL BE RE-WRITTEN FOR v0.3 BASED ON INPUTS FROM THE DATA ANALYSIS PLAN]

The overall Global Solution process is run on command. Portions of the process may run autonomously, depending on certain design decisions. The Global Solution process takes the centroids of grid stars from the centroiding database, attitude information (from either the on-line repository or QL trend database), and other instrumental and spacecraft information from the QL trend database and produces an instrument pointing solution for the spacecraft as a function of time. The solution is valid over the time spanned by the observations. This pointing solution is recorded in a pointing solution database.

As a by-product of this calculation, the astrometric parameters of the grid stars used in the calculation are determined. The following astrometric parameters are written into the working catalog database for grid stars:

- Position and uncertainty in Right Ascension (RA) and Declination (DEC)
- Proper motion and uncertainty
- Plane-of-the-sky acceleration and uncertainty
- Parallax and uncertainty

3.5.3. Astrometric Parameter Calculation

The Astrometric Parameter Calculation process uses the global pointing solution over the valid time period and the centroid and time information from the centroiding database to calculate astrometric parameters for each of the non-grid stars. These results are then written to the working catalog.

3.5.4. Photometric Calibration

The Photometric Calibration process extracts photometry results from the centroiding database for photometric reference stars. These reference stars are then used to calculate a calibration transformation from instrumental magnitude to actual magnitude in TBD photometric system as a function of time, color, CCD, and other TBD information. These calibration transformations are written to a calibration database.

As a by-product of these calculations, the photometric magnitudes and uncertainties are produced for photometric reference stars. These are written to the working catalog database.

3.5.5. Photometric Parameter Calculation

The Photometric Parameter Calculation process uses the calibration solution along with the photometric results from the centroiding database for non-reference stars to calculate photometric magnitudes and uncertainties for non-reference stars. These results are written to the working catalog.

4. APPENDICES

4.1. Acronyms and Abbreviations

APDA	Astrometric and Photometric Data Analysis (subsystem)
CCD	Charged Coupled Device
CTE	Charge Transfer Efficiency
DA	Data Analysis
DEC	Declination
DI	Data Ingestion (subsystem)
DVD	Digital Versatile Disk (also, Digital Video Disk)
ECR	Earth Centered Rotational (coordinate system)
EDF	Engineering Data Formatting (process)
FAME	Full Sky Astrometric Mapping Explorer
FOV	Field of View
FP	Focal Plane
ID	Identification number
MOC	Mission Operations Center
NRL	Naval Research Laboratory
O-C	Observed minus Computed, the difference between simulation results and observed measurements
OCD	Operations Concept Document
OLR	On-Line Repository
PSF	Point Spread Function
QL	Quicklook (subsystem)
RA	Right Ascension
SNR	Signal to Noise Ratio
SOC	Science Operations Center
SOH	State Of Health
TBD	To be determined (typically used in place of a parameter)
TBR	To be resolved (typically used to denote when a parameter is provisional)
TDI	Time Delay Integration
TR	Trending (subsystem)
USNO	United States Naval Observatory